Computer Vision Project: Matching and Restoration of Dunhuang Murals Using Line Drawings

1. Background

The Dunhuang Mogao Cave murals are treasures of ancient Chinese art. However, due to centuries of erosion and aging, many murals have become faded, damaged, or incomplete.

Researchers have created and digitized a large number of **corresponding line drawings** (outline or contour sketches), which preserve the structural information of the original murals.

This project aims to explore how **computer vision and deep learning techniques** can align line drawings with damaged mural images and use the structural cues from line drawings to assist mural restoration.

2. Project Objective

The project should be completed in **three stages**, progressing from traditional methods to deep learning–based solutions:

1. **Traditional Feature Matching:**

    Use classic computer vision algorithms (e.g., SIFT, RANSAC) to match keypoints between line drawings and murals.

2. **Deep Learning–Based Feature Matching:**

    Apply modern deep learning models (e.g., RANSAC-Flow, SuperGlue, LoFTR) to achieve more robust cross-domain feature alignment.

3. **Deep Learning–Based Restoration:**

Utilize the matched image pairs to guide mural restoration with neural network–based image inpainting or restoration models.

The project should be completed **individually.**

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3. Project Description and Requirements

Stage 1: **Traditional Feature Matching**

Goal:

Implement a pipeline to extract and match keypoints between a line drawing and its corresponding mural using traditional methods.

Requirements:

- Extract and visualize feature points
- Use feature matching and filtering techniques (e.g., KNN matching, RANSAC).
- Evaluate and report matching accuracy (e.g., average error, number of inliers).

Deadline: Nov.17

Stage 2: **Deep Learning–Based Matching**

Goal:

Leverage deep learning models to perform robust cross-modal matching between line drawings and murals.

Requirements:

- Choose a suitable pretrained model such as RANSAC-Flow, SuperGlue, LoFTR.
- Implement deep feature extraction and keypoint matching.

- Compare results with Stage 1 (accuracy, robustness, computational cost).
- Visualize the alignment and analyze performance metrics.

Deadline: Dec.8

Stage 3: **Mural Restoration**

Goal:

Use the matched mural-line drawing pairs to perform automatic mural restoration.

Requirements:

- Use the aligned line drawing as a structural reference for mural inpainting.
- Implement a deep learning–based image restoration model.
- Evaluate restoration quality visually and quantitatively (e.g., PSNR, SSIM).
- Present before-and-after restoration comparisons.

Deadline: Dec.29

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4. Data and Resources

Access Details

- **Download Link:** https://dropover.cloud/pxd843da
- **Password:** `100100100`

Data Structure

- **Basic Correspondence:** The file `pic/*-*.jpg` corresponds to the file `line/*-*.jpg`.

- **Special Correspondence (One-to-Many):**
    - **All** images within the `pic/B-5-*` directory correspond to the **single** file `line/B-5.jpg`.
    - **All** images within the `pic/B-6-*` directory correspond to the **single** file `line/B-5.jpg`.
- **Full Images & Crops:** The files `A-2/3`, `B-left` and `B-right` are full-size images. Most other images are crops from these four source images.

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5. Submission Requirements

DELIVERABLE	DESCRIPTION
Source Code	Complete, well-commented scripts that can be executed independently
Report	PDF format, with introduction, method, experiment and conclusion sections. Please follow the provided thesis template requirements.
Visual Results	Keypoint matching plots, alignment visualization, and restoration results